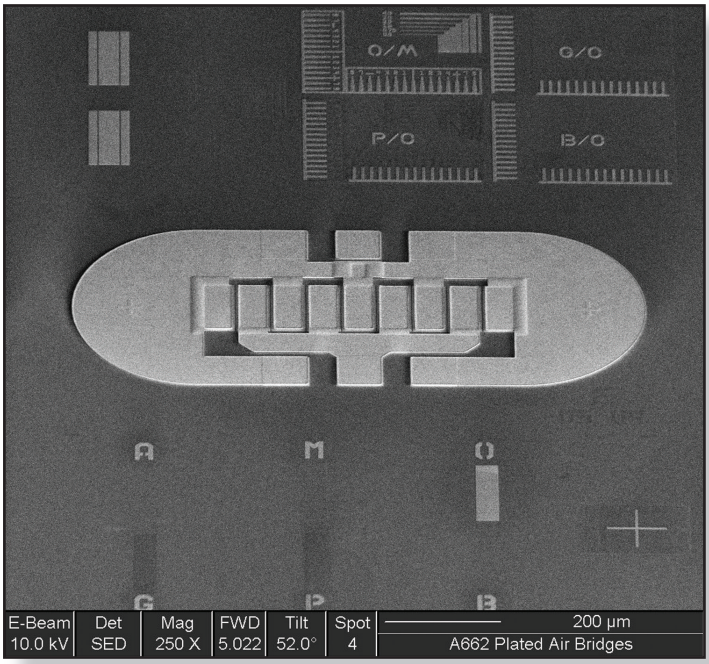
Air Force Research Laboratory|AFRL
*Science and Technology for Tomorrow's Air and Space Force*

# Success Story

## PASSIVATION APPROACH REDUCES RF HEMT GATE AND DRAIN LAG




The Sensors Directorate has overcome a significant technical barrier to the high-performance operation of AlGaN/GaN high electron mobility transistors (HEMT) at X-band frequencies. They have found that wide bandgap materials such as scandium oxide or magnesium oxide, when used as a passivation layer on radio frequency (RF) HEMTs, significantly reduces the gate and drain lag effect in the HEMT. This, in turn, improves the device's ability to operate under high power and high frequency conditions. The long-term benefits of the new passivation approach will improve RF transistor performance and reliability for advanced sensor systems that operate at microwave and millimeter wave frequencies.

Air Force Research Laboratory
Wright-Patterson AFB OH

## Accomplishment

The directorate's RF Devices Team designed a set of experiments to pinpoint the root cause for dispersion in these devices and then tested a number of potential solutions. The directorate collaborated with the University of Florida, who provided molecular beam epitaxial growth of wide bandgap HEMT materials. The team processed the semiconductor material in the directorate's Compound Semiconductor Clean Room Device Facility.

Department of Defense contractors in the wide bandgap semiconductor arena are interested in this directorate-developed passivation process. One industrial partner is working with the RF Device Team and the University of Florida to transfer and integrate the developed passivation technology into their HEMT fabrication process.

## Background

The thin HEMT structure was grown on a 2 in. diameter silicon carbide (SiC) substrate wafer using a metal organic chemical vapor deposition process. The RF Devices Team started with the rigorous process of fabricating HEMT devices on the AlGaN/GaN HEMT material structure. The 2 in. SiC substrate wafer supports the device layers during the processing steps, which include complicated electron beam writing of photoresist to create fine metal geometries on the wafer.

These metal gates serve as the modulating electrode for the HEMT, which typically sources moderate current at low voltages. However, when the wide bandgap passivation is applied to the wafer, both the current and voltage for the device rise dramatically. In addition, the modulation becomes more efficient at high frequencies (10 GHz), where the high power operation of the device is needed for many military sensor applications including phased array radar, electronic warfare jammers, and RF communications transmitters.

Sensors
Technology Transfer

## Additional information

To receive more information about this or other activities in the Air Force Research Laboratory, contact TECH CONNECT, AFRL/XPTC, (800) 203-6451 and you will be directed to the appropriate laboratory expert. (04-SN-12)